Simpson®

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

SIMPSON 474

DIGITAL MULTIMETER

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

SIMPSON ELECTRIC COMPANY
A Katy Industries, Inc. Subsidiary
853 Dundee Avenue, Elgin, Illinois 60120
(312) 697-2260 • Telex 72-2416 • Cable SIMELCO
IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall
IN INDIA: Ruttonsha-Simpson Private, Ltd., Vikhroli, Bombay

DIGITAL INSTRUMENT
Warranty

SIMPSON ELECTRIC COMPANY warrants each digital instrument manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any digital instrument which shall within one (1) year after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any digital instrument which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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DIGITAL MULTIMETER

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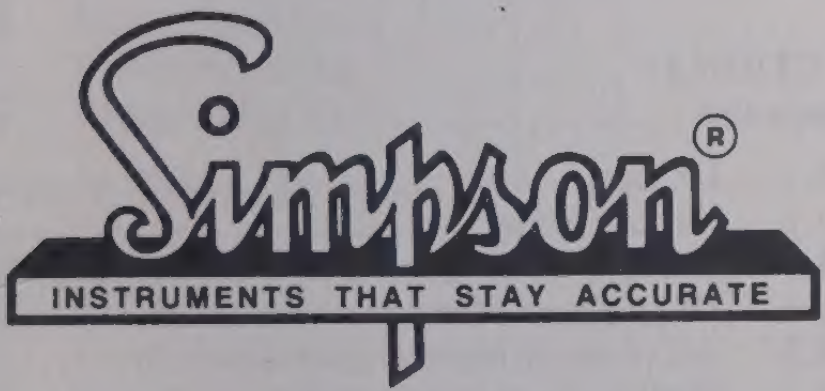

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WARNING

This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

Multi-function instruments such as the 474 are intended as general purpose measuring instruments for use in relatively low power 120/240 VAC or dry battery operated circuits such as found in consumer appliances, home entertainment equipment or general laboratory applications. Some high power circuits, however, are within its measurement range and present an arching/explosion hazard in the event of an unanticipated circuit behavior, a defective measuring instrument, or of an operator error if the operator has not recognized the hazard and observed appropriate personal protective measures. Such high power circuit that would be within the measuring range of this instrument would be found in commercial or industrial equipment operating from AC and DC supply circuits above 240 V, storage battery banks or circuits containing large capacitors. Measurements in such circuits should only be performed by personnel trained to recognize the hazards and using appropriate safety measures. The Safety Precautions in Section IV are intended to alert the operator to the more commonly encountered hazards and protective measures to avoid them. The dangers in high power circuits are serious. Do not take safety precautions lightly.

NOTE: Any circuit containing voltages exceeding 30 V AC or 60 VDC should be considered to be a possible shock hazard, and contact with the circuit should be avoided while the circuit is energized.

SAFETY SYMBOLS

This marking adjacent to another marking or a terminal or operating device indicates that the Operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or to avoid personal injury.

WARNING

This WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly performed or adhered to, could result in personal injury.

CAUTION

This CAUTION sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly adhered to, could result in damage to or destruction of part or all of the Instrument.

HIGH VOLTAGE TERMINAL: A terminal at which a voltage, with respect to another terminal or part, exists or may be adjusted to 1000 volts or more. The symbol is an additional warning that a very dangerous voltage may exist at the terminal, and its connecting leads must not be handled while energized.

GROUNDED TERMINAL (PROTECTIVE): A terminal which must be connected to earth ground by the Operator or Installer prior to making any other connections to the equipment for personal protection from electrical shock.

GROUNDED TERMINAL: A terminal which is connected to earth ground by means of an earth grounding system and which is intended to be connected to other circuits or equipment by the Operator or Installer for purposes other than protection from electrical shock.

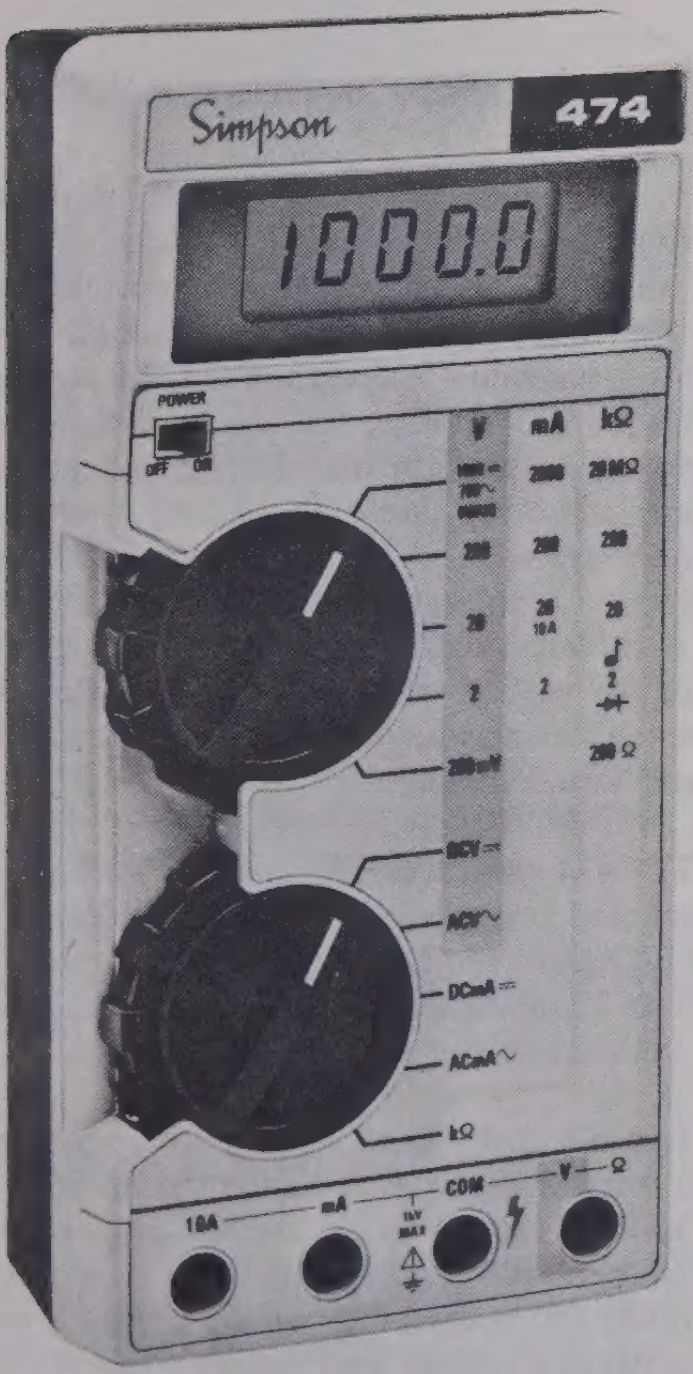

Figure 1-1. Digital Multimeter, 474

SECTION I
INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 474 Digital Multimeter (hereafter referred to as the 474 or simply the Instrument) is a hand-held 4½ digit, compact instrument suitable for use in general electronic maintenance, production and laboratory. This multimeter is designed for the service person who values true portability, reliability, simplicity and the ruggedness of a precision instrument. It features: .03% DC voltage accuracy, single 9V battery operation, large LCD display, transient suppression capability and rotary switch selection for ranges and functions. Additional features are automatic polarity, automatic zeroing, high input impedance for voltage measurements, excellent overload protection characteristics and continuity detection with audible and visual indication.

1.1.2 The 474 measures DC and AC voltage, DC and AC current and resistance as specified in Table 1-2. The Analog-To-Digital (A/D) conversion circuitry is contained in one Large-Scale Integration (LSI) module which provides high reliability and compact design.

1.1.3 The 474 is designed to operate continuously for 200 hours using a single 9V alkaline "transistor" battery (NEDA 1604A). However, a carbon-zinc type battery (NEDA 1604) may be substituted. (Operation will be reduced to 100-150 hours.) "B" on the display is used to indicate low battery voltage and signify a battery life of 20 hours remaining.

1.1.4 The numerical display is a 4½ digit, 7-segment liquid crystal display (LCD). The high contrast numerals are 0.4 inches high and are in a single plane for distant and wide angle viewing.

1.2 SUPPLIES AND ACCESSORIES

1.2.1 All supplies and accessories required for the operation of the 474 are furnished with the Instrument, and listed in the accompanying Table 1-1. Available replacement parts are listed in Table 7-2.

Table 1-1. Items and Accessories Furnished With This Instrument

Quantity	Description	Part No.
1	Operator's Manual	6-113168
1	Battery, 9 V Alkaline (NEDA 1604A)	5-114907*
1	Test Lead Set: One black and one red insulated lead having probe tips with screw-on alligator clips.	00043
1	Alligator Clip Accessory Kit	10-864240

*Batteries are standard items replaceable through local retail stores.

1.3 SAFETY CONSIDERATIONS

1.3.1 This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and service conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and are defined at the front of the manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of the Instrument, these instructions must be adhered to.

1.4 TECHNICAL DATA

1.4.1 Table 1-2 lists the technical specifications for the 474 Digital Multimeter.

Table 1.2 Technical Data

The following electrical specifications are valid for an operating temperature of +18°C to +28°C at relative humidity up to 90 percent unless otherwise noted.

1. DC Voltage:

Ranges:	200 mV, 2 V, 20 V, 200 V, 1000 V
Accuracy:	±(0.03% of input + 2 counts) to 200 mV range, ±(0.07% of input + 1 count) to 1000 V range
Input Resistance:	10 MΩ, all ranges
Overload Protected to:	±1000 V (DC + peak AC), all ranges except 200 mV range which is 250 V (DC + peak AC)
Resolution:	10 μV on 200 mV range
Full Range Step Response (to rated accuracy):	1 second
Normal Mode Rejection:	50 dB minimum at 50/60 Hz
Common Mode Rejection:	120 dB minimum at DC; 100 dB minimum at 50/60 Hz

2. AC Voltage:

(Average-sensing, rms calibrated sine wave)

Ranges: 200 mV, 2 V, 20 V, 200 V, 750 V

Range	Accuracy*	
	45 Hz to 500 Hz	**500 Hz to 1 kHz**
200 mV	±(1.0% + 5)	±(1.0% + 10)
2 V		±(3% + 10)
20 V		±(1.0% + 10)
200 V		
750 V		

**% of input + number of counts (5% to 100% of range)*

Input Resistance: 10 MΩ and 100 pF, all ranges

Overload Protected to: 1000 V (DC + peak AC), all ranges except 200 mV range which is 250 V (DC + peak AC)

Resolution: 10 μV on 200 mV range

Full Range Step Response (to rated accuracy): 3 seconds

3. RESISTANCE:

Ranges: 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 20 MΩ

Accuracy: ±(0.2% of input + 10 counts) on the 200 Ω range, ±(0.2% of input + 2 counts) on 2 kΩ, 20 kΩ, 200 kΩ ranges, and ±(0.4% of input + 2 counts) on 20 MΩ range

Open Circuit Voltage:	<3.5 V, all ranges
Overload Protected to:	250 V rms, all ranges
Resolution:	0.01 Ω on 200 Ω range
Full Range Step Response (to rated accuracy):	1 second except on 20 MΩ range which is 12 seconds at 10 MΩ.
Diode Test:	Diode symbol indicated on 2 kΩ range switch position. Measures forward resistance of a semiconductor junction, at approx. 1.0 mA test current.
Continuity: (on 2 kΩ range)	200 Ω typical or less activates audible tone and display indication. Overrange de-activates audible tones and display indication.

4. DC CURRENT:

Ranges:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Accuracy:	±(1% of input + 1 count) except on 2000 mA and 10 A ranges which are ±(2% of input + 1 count)
Burden Voltage:	0.25 V max. except 0.9 V max. on 2000 mA range, 0.3 V max. on 10 A range
Overload Protected to:	±2 A high energy fuse protected, all ranges except 10 A range
Full Range Step Response (to rated accuracy):	1 second

5. AC CURRENT:
(45 Hz to 1 kHz)

Ranges:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Accuracy:	±(2% of input + 5 counts) except on 2000 mA and 10 A ranges which are ±(3% of input + 5 counts). (5% to 100% of range.)
Burden Voltage:	Same as DC (see above)
Overload Protected to:	2 A high energy fuse protected, all ranges except 10 A range
Full Range Step Response (to rated accuracy):	3 seconds

6. RATED CIRCUIT-TO-GROUND VOLTAGE

(max. common mode voltage):	1000 volts (DC + peak AC) between any input terminal and power line (earth) ground

7. TRANSIENT PROTECTION: Protected against transients on all voltage and resistance ranges: 6 kV for 100 μsec max.

8. DISPLAY:

Numerical Display:	4½ digit, 7-segment liquid crystal display (LCD) type, with "low battery" indication and continuity indication (activated by 200 Ω typical or less).
Conversion Rate:	1.5 readings per second minimum

Overrange indication (input greater than maximum indication):	Most significant digit "on," all others off.
DC Polarity Selection:	Automatic "−" indication, "+" implied

9. POWER REQUIREMENT:

Battery Type:	(1) 9-volt "transistor" battery, alkaline (NEDA 1604A) or carbon-zinc (NEDA 1604)
Battery Life:	200 hours nominal with alkaline battery

10. TEMPERATURE RANGE:

Operating:	0° to +55°C
Storage:	−40° to +70°C

11. TEMPERATURE COEFFICIENT: (0° to +18°C and +28° to +55°C) Less than 0.1 times the applicable accuracy specification per °C

12. HUMIDITY RANGE: 90% max., 0° to +35°C; 70% max., +35° to +55°C (non-condensing)

13. DIMENSIONS:

Height:	1.8″ (4.57 cm)
Width:	3.4″ (8.64 cm)
Depth:	7.1″ (18.03 cm)

14. WEIGHT: 1.0 lb. (.453 kg)

SECTION II
PREPARATION FOR USE

2.1 GENERAL

2.1.1 This section contains instructions for preparing the new instrument for use. Included are unpacking inspection procedures, warranty, shipping and power source requirements.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. Inspect the Instrument for possible damage incurred during shipment. If damage is noted, notify the carrier and supplier and do not attempt further use of the Instrument. If the Instrument appears to be in good condition, read the Operator's Manual in its entirety. Become familiar with the Instrument as instructed in the manual, then proceed to check the electrical performance as soon as possible. Also, check that all items are included with the Instrument (Table 1-1).

2.3 WARRANTY

2.3.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact the nearest Authorized Service Center for instructions (listed on the last pages of this manual.) If it's necessary to contact the factory directly, give full details of any difficulty and include the Instrument model number, serial number (at the back of the Instrument) and date of purchase. Service data or shipping instructions will be mailed promptly. If an estimate of charges for non-warranty or other service work is required, a charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the Instrument carefully and ship prepaid to the proper destination. Insure the Instrument.

2.5 POWER SOURCE REQUIREMENTS

2.5.1 The 474 is a battery operated instrument. A 9 V "transistor" battery is supplied with the Instrument. (See item 9, Table 1-2 for battery type and paragraph 6.3 for installation.)

2.6 OPERATING POSITION

2.6.1 As well as being hand held operated, the Instrument may also be operated while set on its rubber feet on its back, at an inclined angle with the bail extended, or at a hanging position with bail repositioned, as shown in Figure 2-1.

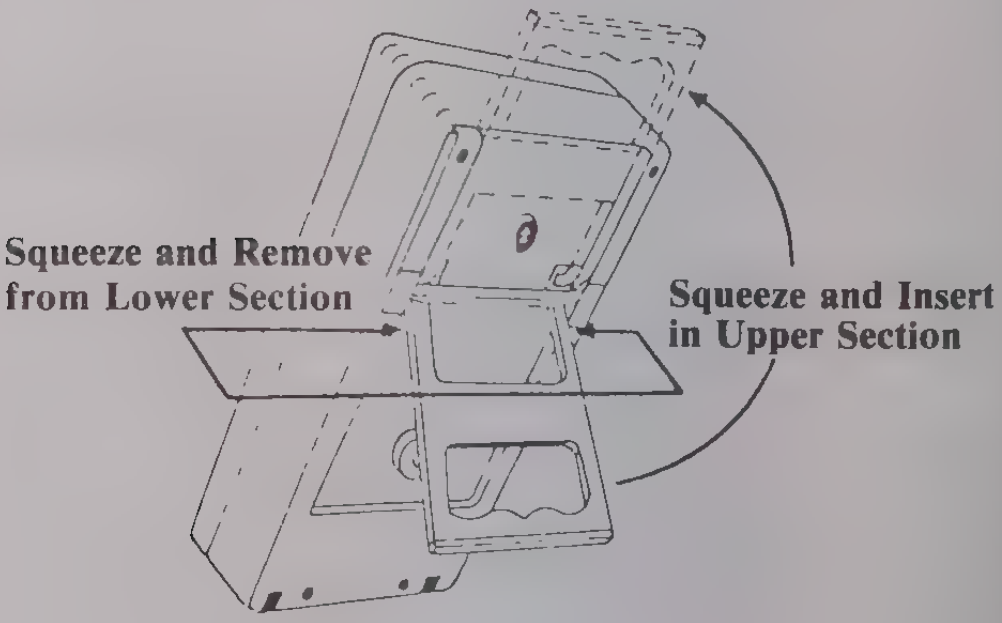

Figure 2-1. Bail Repositioning

SECTION III
CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

3.1.1 All operating controls, connectors and indicators are described in this section. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT PANEL DESCRIPTION

3.2.1 Table 3-1 lists all front panel controls, connectors and indicators (Figure 3-1 for identification).

Table 3-1. Front Panel Description

1. POWER SWITCH: ON OFF	Slide switch used to apply or turn off power to the Instrument
2. FUNCTION SWITCH:	Connect the input to the appropriate measuring circuits as follows: DCV ⎓ = DC Voltage ACV ∿ = AC Voltage DC mA ⎓ = DC Milliamps AC mA ∿ = AC Milliamps kΩ = Resistance
3. RANGE SWITCH:	Selects the appropriate circuits required to obtain full range measurements as follows:
Voltage:	200 mV, 2 V, 20 V, 200 V, 1000 VDC/750 VAC
Current:	2 mA, 20 mA, 200 mA, 2000 mA, 10 A
Resistance:	200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 20 MΩ

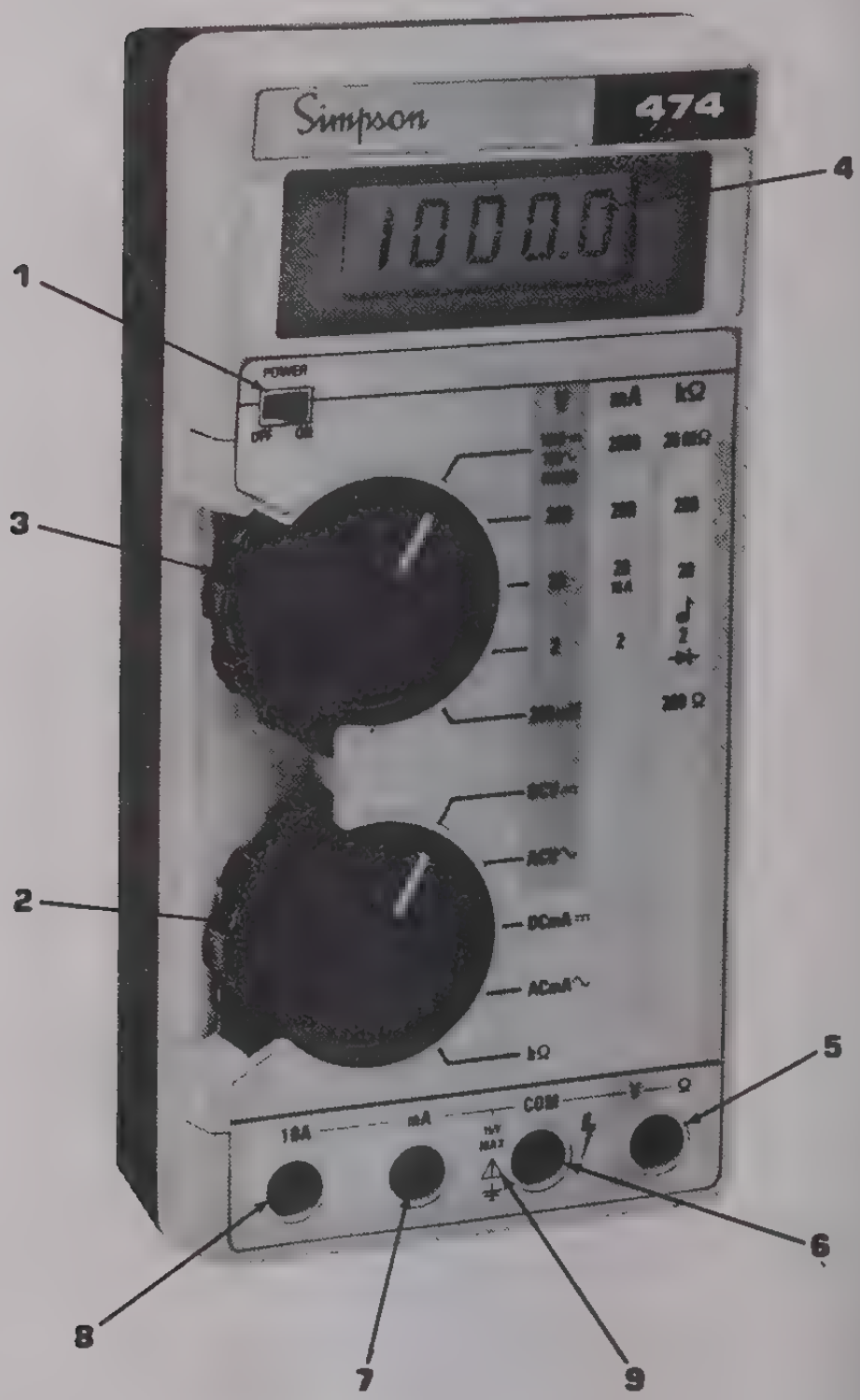

Figure 3-1. Front Panel Description.

4. NUMERICAL DISPLAY: The digital display is a single LCD which includes a "- " polarity sign ("+" sign is implied), a "1" digit, three 7-segment 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the selection of the range switch. Overrange (or out of range) conditions are indicated by a blank display, except for the most significant "1" digit.

Low battery condition is indicated by "B" located on the upper left-hand corner of the display. The first appearance of "B" signifies a remaining battery life of approximately 20 hours.

5. V-Ω JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to all voltage and resistance measuring circuits through the range and function switches.

6. COM JACK: This jack is used to connect, via the black test lead, the "low" or "–" side of the circuit being measured to the internal circuit COMMON and is isolated from the AC power line ground. Do not float this terminal more than 1000 (DC plus AC peak) volts away from earth ground.

7. mA JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to the current measuring circuits through the range and function switches up to 2000 mA.

8. 10 A JACK: This jack serves the same purpose as mA JACK, but for higher current measurement up to 10 A.

9. ⚠ Refer to Table 1-2, item 6.

SECTION IV
OPERATING INSTRUCTIONS

4.1 GENERAL

WARNING

Voltages encountered within the capabilities of this Instrument are dangerous and can be fatal. Read and follow fully the instructions provided in this Operator's Manual and adhere to the following:

4.1.1 Turn off circuit power before connecting and disconnecting test leads.

4.1.2 Do not float the input terminals more than 1000 volts (DC + peak AC) from earth ground.

4.1.3 Do not use this Instrument for making measurements in high voltage and high power circuits unless qualified to do so.

4.1.4 Do not exceed the following input limits:

Function	Maximum Input
AC/DC Volts:	±1000 V (DC + peak AC)
	±250 V (DC + peak AC) on 200 mVAC range
AC/DC mA:	2 A (Fuse Protected)
Ohms:	250 V rms

Failure to stay below these limits can lead to personal injury and/or damage to the Instrument.

4.1.5 For maximum safety, do not touch test leads, circuit or Instrument while power is applied to the circuit being measured.

4.2 BATTERY POWER

4.2.1 Type and Life

4.2.2 The 474 is designed to operate on a single 9 V "transistor" battery (NEDA 1604A for alkaline; NEDA 1604 for carbon-zinc). An alkaline 9 V battery is supplied with the Instrument. Up to 200 hours of continuous operation can be achieved using an alkaline battery; up to 150 hours using a carbon-zinc battery.

4.2.3 Low Battery Indicator

4.2.4 The 474 will automatically detect and display "B" (upper left-hand corner of display) when the battery voltage is below 7.0 volts approximately. The first appearance of the "B" signifies a remaining battery life of approximately 20 hours.

4.3 GENERAL FUNCTIONAL CHECK

NOTE: Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

a. Connect the black test lead to the COM jack and the red test lead to the V-Ω jack. Short the test leads together.

b. Set the function switch to kΩ and the range switch to 2.

c. Separate the test leads. The numerical display will blank in the out-of-range condition.

d. Short the test leads together. The display reading will return to .000 ±2 counts.

e. If difficulty is encountered in the above steps, see Section 7, Table 7-1.

4.4 DC VOLTAGE MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to DCV ⎓.

d. Set the range switch to the appropriate range. If the voltage being measured is unknown, begin with the 1000 volt DC range.

e. REMOVE ALL POWER FROM THE DEVICE OR CIRCUIT UNDER TEST AND DISCHARGE ALL CAPACITORS.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1000 volts DC.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity, " – " to indicate negative and no sign to imply positive polarity. The value of the voltage being measured will be indicated on the numerical display.

h. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS PRIOR TO DISCONNECTING TEST LEADS.

4.5 AC VOLTAGE MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to ACV~.

d. Set the range switch to the appropriate range. If the voltage being measured is unknown, begin with the 750 VAC range.

CAUTION

Do not attempt to measure voltages on the 750 VAC range which might be greater than 750 volts.

e. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display.

h. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS PRIOR TO DISCONNECTING TEST LEADS.

4.6 RESISTANCE MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Set the function switch to kΩ.

d. Set the range switch to the appropriate range.

e. If the resistance being measured is connected into a circuit, be certain that all power is removed from the circuit and all capacitors are discharged. Check for current paths other than through the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

f. Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the actual value.

g. Allow time for the display to stabilize. This procedure is especially important when measuring a high value resistance shunted by a large value of capacitance.

h. Disconnect test leads.

NOTE: When measuring low resistance values (200 ohm range):

(1) determine and record the resistance value of the test leads being used. This is done by shorting the ends of the test leads together,

(2) connect the test leads to the resistance under test. Make sure the connections are electrically clean and mechanically secure,

(3) The value of the resistance under test is equal to the value indicated on the readout minus the lead resistance determined in step (1) above.

4.6.1 DIODE TEST:

a. Set the function switch to "kΩ" function.

b. Set the range switch to "2" range.

c. To measure the forward resistance of a semiconductor junction, connect the cathode of the diode to the COM terminal and anode to the V-Ω terminal. For silicon diodes, the Instrument should display .550 or higher. For germanium diodes, the Instrument should display .450 or lower.

d. To measure the reverse resistance of a semiconductor junction, the Instrument should display "overrange."

4.6.2 CONTINUITY TEST:

a. Set the function switch to kΩ and the range switch to "2."

b. Connect the red lead and the black lead to the V-Ω and COM jacks respectively.

c. No audible tone should be generated with open test leads.

d. An audible tone and a visual annunciator should be generated with shorted test leads or connected to a 300 Ω or lower resistance (approx.).

4.7 DC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1.

b. Set the function switch to DCmA⎓.

c. Select the appropriate current range switch. If the current being measured is unknown, begin with the 10 A range.

d. REMOVE ALL POWER TO THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Connect the red test lead to the 10 A jack* and the black test lead to the COM jack.

**mA jack for measuring any current less than 2000 mA.*

f. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 474 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 474 (refer to Table 1-2, item 6).

g. Apply power to the circuit being measured.

h. The value of current being measured is indicated on the numerical display.

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

4.8 AC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.1.

b. Set the function switch to AC mA$\sim$.

c. Select the appropriate current range switch. If the current being measured is unknown, begin with the 10 A range.

d. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 474 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 474 (refer to Table 1-2, item 6).

f. Connect the red test lead to the 10 A jack* and the black test lead to the COM jack.

g. Apply power to the circuit being measured.

h. The value of the current being measured is indicated on the numerical display.

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

**mA jack for measuring any currrent less than 2000 mA.*

SECTION V
THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system block diagram for the 474 is shown in Figure 5-1.

5.1.2 Signal Conditioning Section: The parameter being measured is connected to the input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, AC-to-DC Converter, and associated switching.

5.1.3 Analog-to-Digital Converter Section: The Analog-to-Digital (A/D) Converter section changes the DC output voltage from the Signal Conditioning section to digital information. Using a Large-Scale Integration (LSI) circuit, the unique A/D Converter automatically eliminates zero error. The Continuity Detector determines whether or not the conditioned input DC voltage level or pulse exceeds a predetermined reference level and appropriately activates the audible tone and visual annunciator on 2 kΩ range.

5.1.4 Display Section: The Analog-to-Digital (A/D) Converter decodes the BCD into 7-segment information by the onboard decoder-driver. It also includes a backplane drive. The LCD display is driven directly by the Analog-to-Digital converter chip.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements: The basic DC Voltage circuit is shown in Figure 5-2(A). The DC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected and converted into digital information by the A/D Converter.

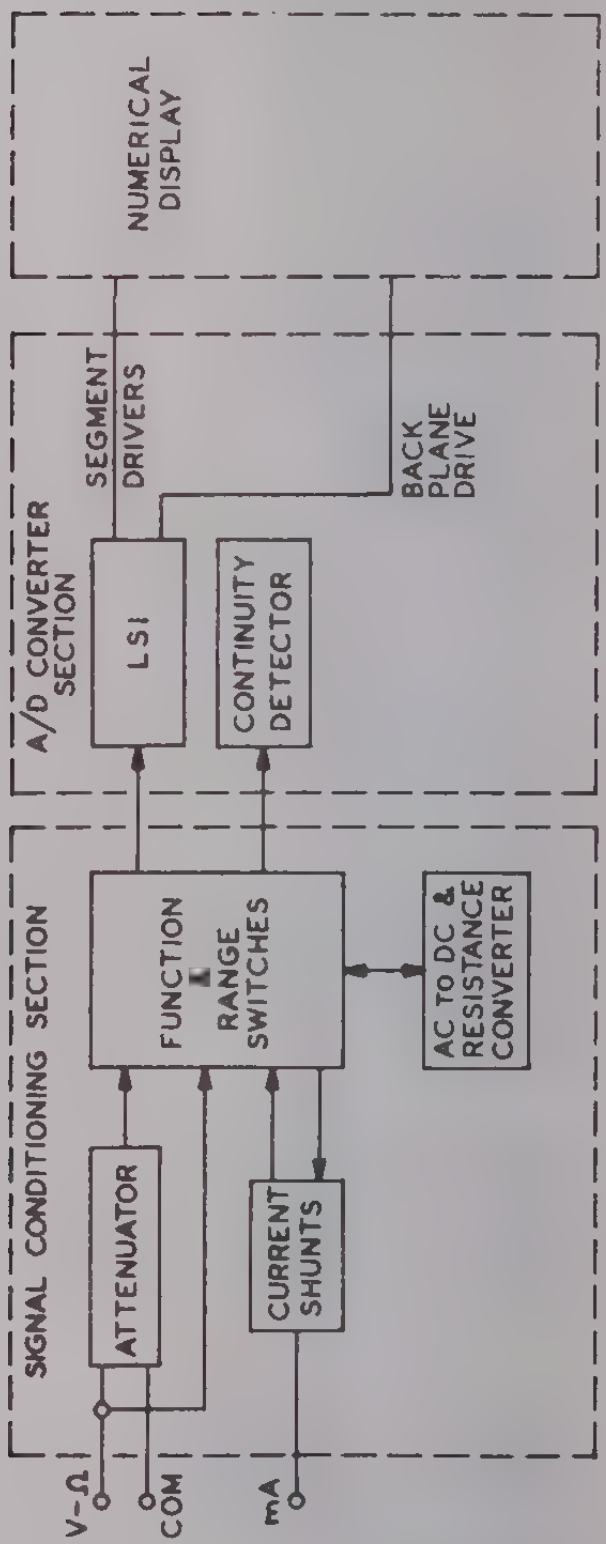

Figure 5-1. Basic System Diagram

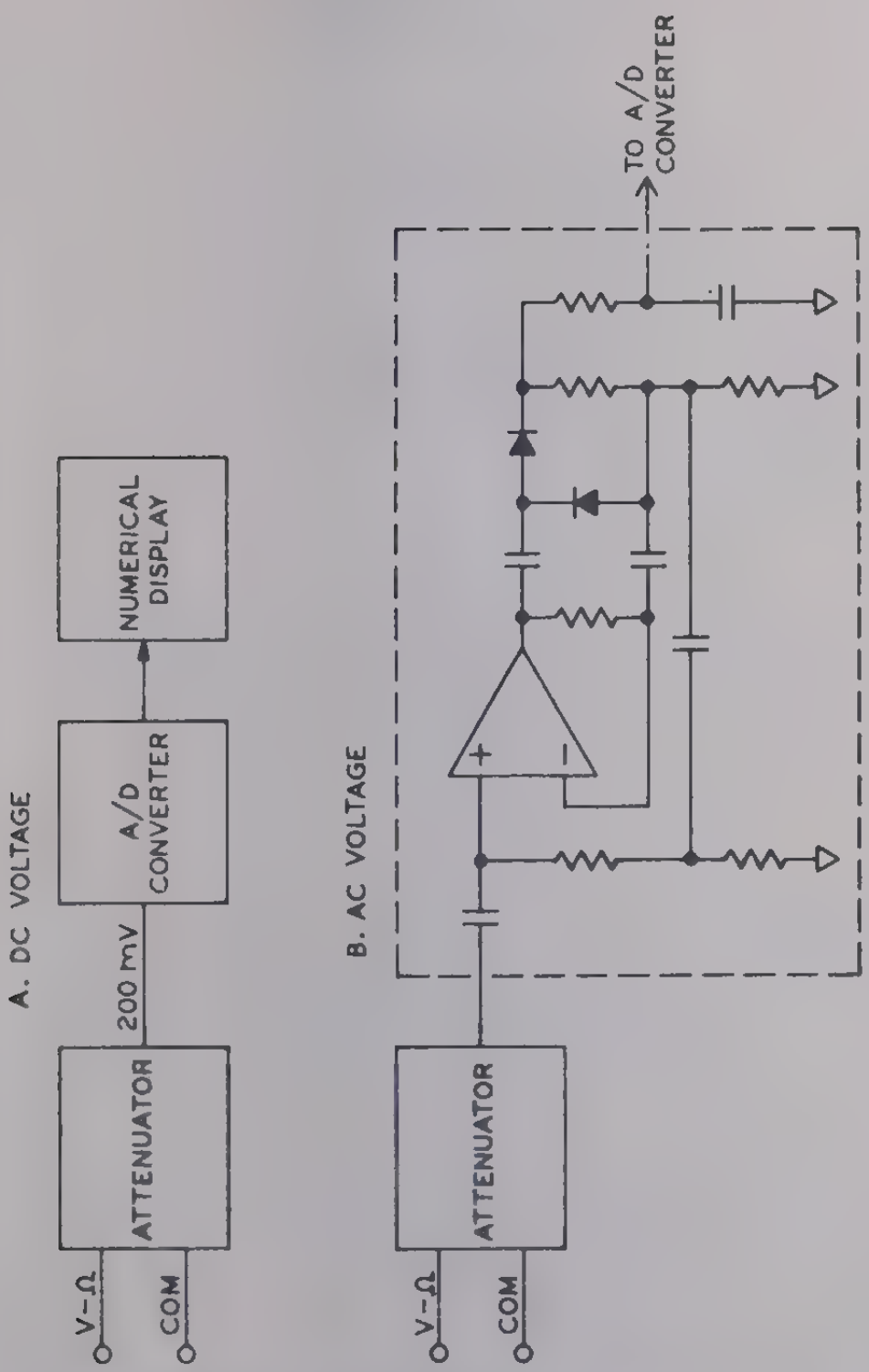

Figure 5-2. Basic Voltage Measurement Circuits

5.2.2 The A/D Converter provides a basic 200 mV sensitivity range. The input voltage being measured is attenuated to provide 200 mV range by the input divider network. The divider network is used on the 2 V, 20 V, 200 V and 1000 V ranges.

5.2.3 AC Voltage Measurements:

5.2.4 The basic AC Voltage measurement circuit is shown in Figure 5-2(B).

5.2.5 The AC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected by the range switch.

5.2.6 The attenuator attenuates the input signal to provide a 200 mV full scale signal for A/D converter.

5.2.7 The AC to DC Converter uses an effective half wave operational amplifier/rectifier circuit which provides a basic 200 mV full range sensitivity. The converter is average responding but its calibration is based on the rms value of a sine wave.

5.2.8 DC Current Measurements:

5.2.9 The basic DC current measurement circuit is shown in Figure 5-3(A). The current being measured is connected in series with the "mA" or "10 A" and "COM" jacks across the internal precision shunt resistance. The value of the shunt resistance depends on the current range selected. The DC voltage developed across the shunt resistor is measured by the A/D Converter.

5.2.10 The full range sensitivity of the A/D Converter is set for 200 mV. The internal shunt resistance for each current equals 200 mV divided by the full range current. For example, if the full range current is 2 mA, the shunt resistance is 100 ohms.

5.2.11 AC Current Measurements: The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (paragraph 5.2.8), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

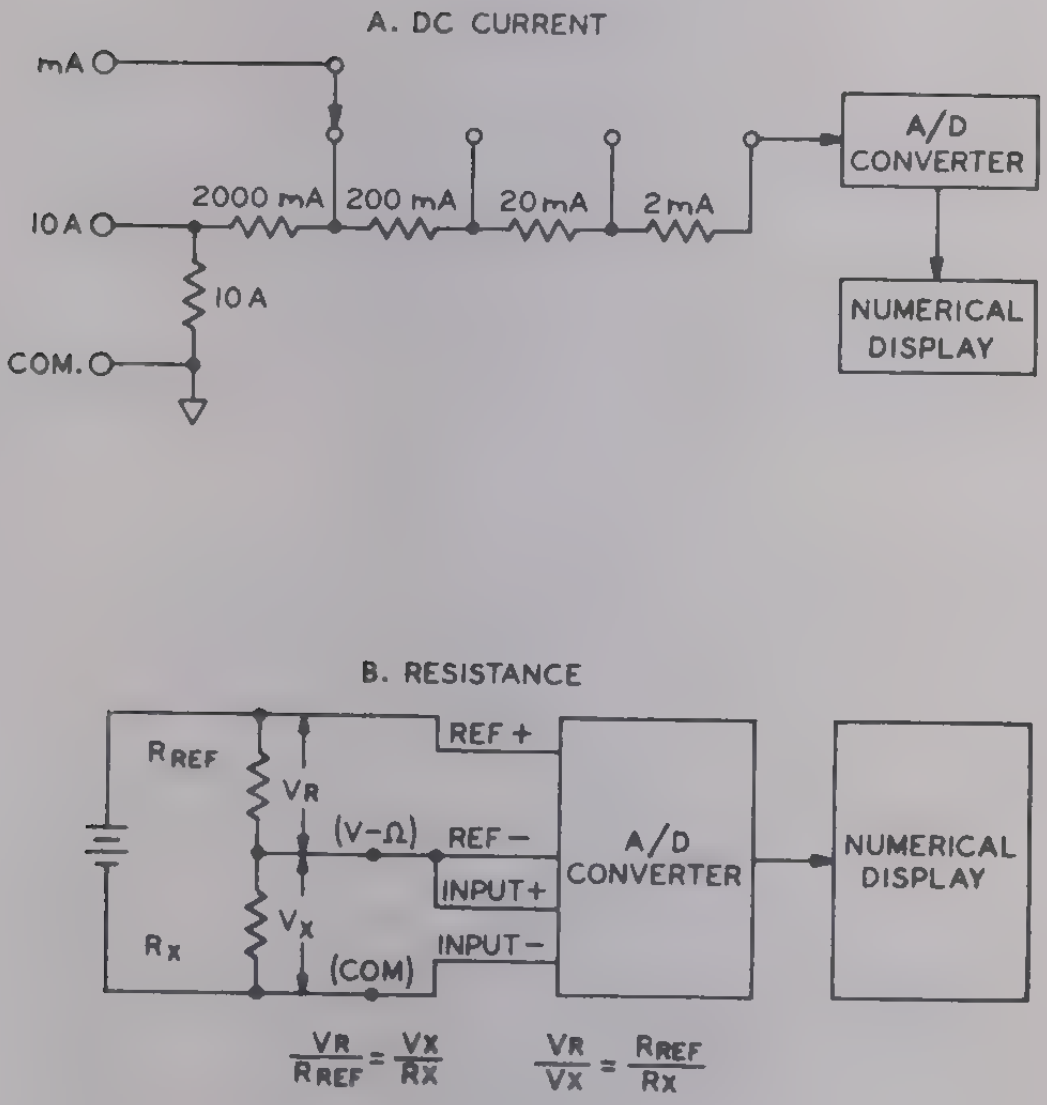

Figure 5-3. Basic Current and Resistance Measurements Circuits

5.2.12 Resistance Measurements:

5.2.13 The basic resistance circuit is shown in Figure 5-3(B).

5.2.14 The resistance being measured, Rx, is connected to the "V-Ω" and "COM" jacks. A voltage ratio is made by comparing the unknown resistance (Rx) with an internal standard resistance R ref. The voltage ratio is applied to the A/D converter to yield a numerical value which is proportional to the unknown resistance as shown in Figure 5-3(B). The ranges of the resistance measurement circuit are determined by the range switch setting.

5.2.15 For semiconductor junction test, refer to paragraph 4.6.2 diode test.

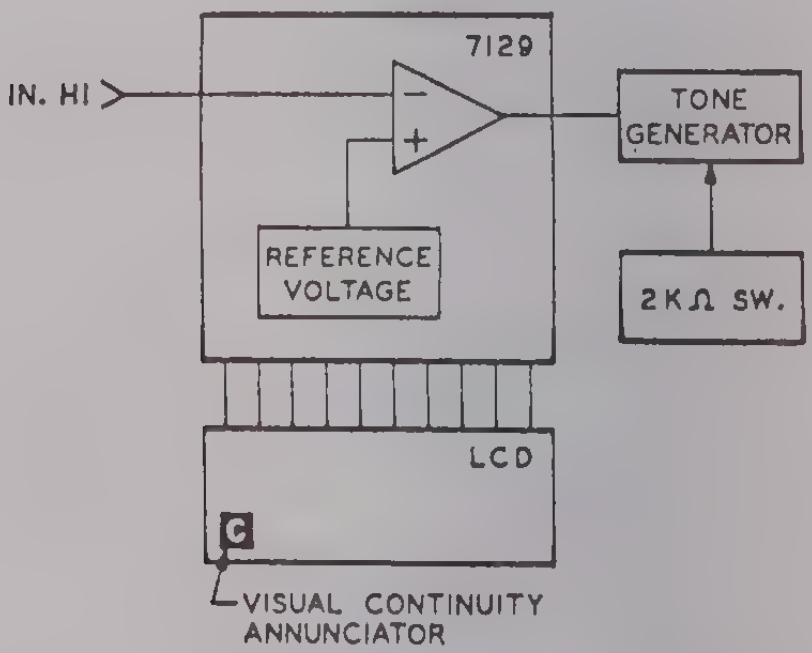

Figure 5-4. Basic Continuity Detector

5.2.16 Continuity Detector: The basic circuit is shown in Figure 5-4. An internal comparator compares the input signal, which is the voltage drop across the Rx and the protection resistor, with a Reference Voltage. The high level output of the comparator in conjunction with 2 kΩ range enables the audible tone and visual indication if a "below reference" signal level is detected.

SECTION VI
OPERATOR MAINTENANCE

6.1 GENERAL

6.1.1 This section will describe the necessary procedures needed to effectively service the 474.

6.2 BATTERY DOOR REMOVAL

6.2.1 The battery door can be removed for servicing by using the following procedures:

WARNING

Remove all power and connections to the Instrument before removing the battery door. Do not operate the Instrument with the battery door removed.

a. Set the POWER switch to the OFF position.

b. Disconnect the test leads from the Instrument.

c. Unscrew the battery door's captive screw until it stops; with a thumb placed over each one of the "engraved" arrows on the door, depress slightly; then push door up (in the direction of the arrows) to remove it.

d. Reverse this procedure when replacing the door.

6.3 BATTERY INSTALLATION/REPLACEMENT PROCEDURES

6.3.1 Use the following procedure to install or replace the battery:

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the 474 input terminals.

c. Remove the battery door.

WARNING

Remove both test leads from input terminals before removing the door. Do not operate the Instrument with the battery door removed.

d. Lift the battery from the compartment and remove the battery connector.

e. Press the battery connector on the new battery and return the battery to the compartment.

f. Replace the battery door.

NOTE: When the battery reaches the end of its useful life, replace it promptly. Failure to do so may result in corrosion at the battery contacts.

6.4 FUSE REPLACEMENT

6.4.1 Both AC and DC current functions are protected up to 2 amps with two fuses, F1 and F2. The fuses are connected in series and are accessible with the removal of the battery door (Figure 6-1).

6.4.2 Fuse types:

F1: 3AG, 2A, 250 V, Normal blow.
F2: BBS, 3A, 600 V

6.4.3 Fuse Replacement Procedures:

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the 474 input terminals.

c. Remove the battery door.

d. Carefully remove and replace the defective fuse(s).

WARNING

The combination of fuses provided in this Instrument will perform properly only when the specified types and values of fuses are used. Using incorrect fuses will reduce the protection afforded to the Instrument and can endanger the operator if he's working in high voltage, high power circuits.

e. Replace the battery door.

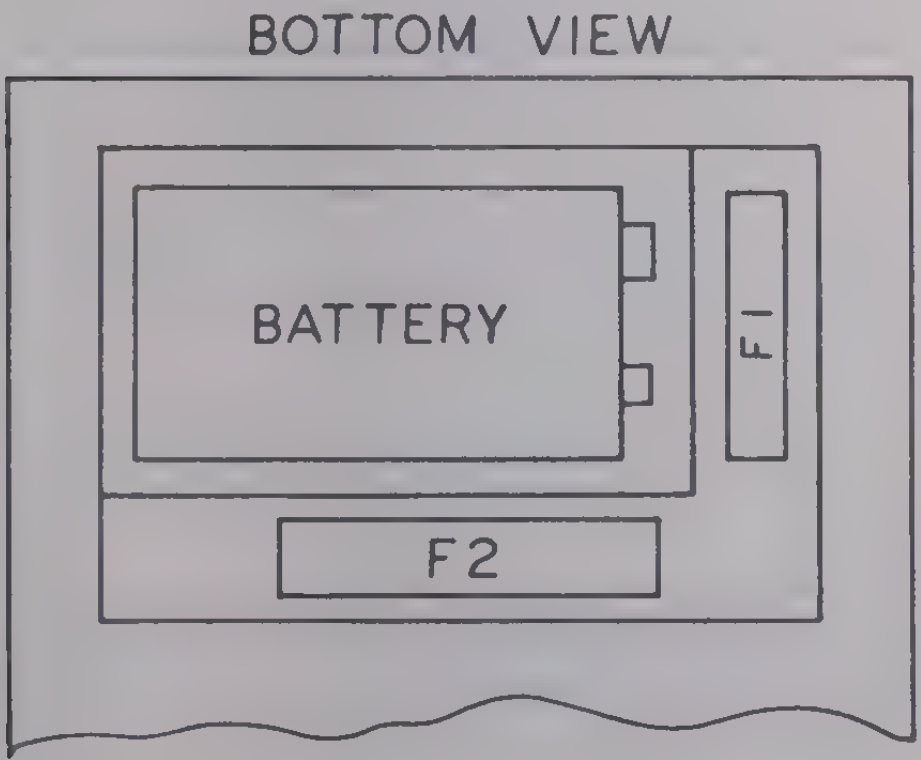

Figure 6-1. Fuse Location, 474

6.5 CARE:

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source.

a. Immediately clean all spilled materials from the Instrument and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces.

b. Do not allow the battery to fully discharge. (A completely discharged battery may be forced into reverse polarity which will shorten battery life.)

c. Whenever possible, avoid exposure to or usage in areas which are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical electromagnetic interferences.

6.5.1 Monthly Care: Verify Instrument calibration by performing operational checks using known value sources. If a need for calibration is indicated, contact the nearest Authorized Service Center.

6.5.2 Annual Care: It is recommended that the Instrument be returned annually to an Authorized Service Center or to the factory for a complete overall check and calibration.

6.5.3 Storage: When the Instrument is not in use, store it in a location free from temperature extremes, dust, corrosive fumes, and mechanical vibration or shock.

WARNING

The following servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION VII
SERVICING INSTRUCTIONS

7.1 GENERAL

7.1.1 The following paragraphs discuss troubleshooting procedures and replacement parts for the 474. Read and heed these instructions carefully.

7.2 TROUBLESHOOTING

7.2.1 If the Instrument does not yield satisfactory results, follow these procedures before attempting maintenance on the Instrument.

a. Review and comply with paragraph 4.3, General Functional check.

b. Check that all switches are positioned correctly for the parameter and range of the value being measured and that the measurement situation is within the rating of the Instrument.

c. Be sure that the battery is properly installed (paragraph 6.3).

d. Ensure that the environment in which the Instrument is being used is within the Instrument specifications.

e. Inspect the device being measured and the measurement test set-up to ensure that proper shielding and grounding techniques have been used. Also, consider whether the Instrument is significantly affecting the circuit being measured.

7.2.2 If the steps taken in paragraph 7.2.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 7-1). If further assistance is needed, contact an Authorized Service Center.

Table 7-1. Troubleshooting Chart.

- SYMPTOM:

  "B" appears on display.

  PROBABLE CAUSE:

  Battery reached the end of its useful life.

  CURE:

  Replace the battery as noted in paragraph 6.3.

- SYMPTOM:

  No display or faded display when the Instrument is turned "ON."

  PROBABLE CAUSES:

  Battery defective, not installed properly, making poor contact, or missing.

  CURE:

  Remove battery door and check that the battery is installed correctly and making good contact. Install or replace battery if necessary. (Refer to paragraph 6.3.)

- SYMPTOM:

  Indications fluctuate and/or drift, even though indication is satisfactory at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance source.

  PROBABLE CAUSE:

  Fluctuations, and/or drift are being generated by the circuit being measured or the measurement test set up.

CURE:

Use proper shielding gounding techniques and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling.

- SYMPTOM:

Slow response. Operation OK when using a low impedance input.

PROBABLE CAUSE:

Parameter being measured has a high source impedance.

CURE:

None required.

- SYMPTOM:

Accuracy not within specifications when checked with a stable higher accuracy (at least 5 times better) low impedance (voltage measurements) source.

PROBABLE CAUSE:

Instrument is out of calibration.

CURE:

Contact the nearest Authorized Service Center.

- SYMPTOM:

Operation normal on all functions and ranges except AC and DC Current.

PROBABLE CAUSE:

Current fuse F1 open.

CURE:

Replace fuse F1 (Refer to paragraph 6.4).

SYMPTOM:

Operation normal on all functions and ranges except AC and DC Current (F1 checks OK).

PROBABLE CAUSE:

Current fuse F2 open.

CURE:

If F2 has been blown, a large amount of energy has been applied to the current ranges. Circuit conditions must be corrected before replacing F2. (Refer to paragraph 6.4.)

.3 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

.3.1 This section contains information for ordering eplacement parts and shows the Schematic Diagram Figure 7-1). Table 7-2 lists parts in alpha-numeric order of heir reference designators and indicates the description Refer to Table 1-1 for Items and Accessories Furnished Vith This Instrument.)

.3.2 To obtain replacement parts, address order to the iearest Authorized Service Center (listed on the last pages of this manual). Refer to paragraph 2.3.1 for ordering nstructions.

Table 7-2. Replacement Parts

*Batteries and fuses are standard items replaceable through local retail stores.

Symbol	Description	Part No.
B1	Battery, 9 V	5-114907*
	Test Lead Set, Red and Black w/o Alligator Clips	00043
	Alligator Clip	10-864240
F1	Fuse, 2 A, 250 V, 3AG	1-112911*
F2	Fuse, 3 A, 600 V, BBS	6-110906*
C101	Capacitor, 0.022 μF, 630 V, Polyester	6-112832
C102,104	Capacitor, 0.1 μF, 100 V,	
C114	Mylar	6-113162
C103	Capacitor, 10 μF, 20 V, TAT	6-110306
C105	Capacitor, 1 μF, 16 V, TAT	5-115531
C106,116,112	Capacitor, 15 μF, 16 V, Electrolytic	6-113031
C107	Capacitor, .033 μF, 100 V, Mylar	6-113154
C108	Capacitor, .22 μF, 100 V, Mylar	6-113283
C109	Capacitor, .047 μF, 100 V, Mylar	6-113153
C110	Capacitor, .15 μF, 100 V, Polypropylene	6-113152
C111	Capacitor, 10 pF, 50 V, Ceramic Disc	5-119319
C113	Capacitor, 470 pF, 500 V, Ceramic Disc	1-115832
C115	Capacitor, .022 μF, 100 V, Mylar	6-112161
D101,102,103	Diode, 1N914	5-112004
D104,105	Diode, 1N6263, Matched Pair	3-813018
D106,107	Diode, 1N5059	6-113826
D108	Diode, 1N4001	5-113200

Symbol	Description	Part No.
IC101	IC, TL061CP	6-113008
IC102	IC, CD4093CD	6-112216
IC103	IC, Diode, Reference, ICL 8069CCZR	6-113156
IC104	IC, ICL 7129	6-113034
IC105,106	IC, CD4053	6-112215
MOV 101,102, MOV 103,104	MOV	6-110694
Q101,102,104, Q105,106,107	Transistor, 2N4123	5-115931
Q103	Transistor, MPS 3702	5-113864
R101	Resistor, 100 k, 10%, 1 W	6-113157
R102	Resistor, 1 k, 5%, 3 W	5-119931
R103	Resistor, 10 k, 5%, .25 W	5-118161
R104	Resistor, 560 k, 5%, .25 W	5-114984
R105	Resistor, Special, Attenuator	6-112780
R106	Resistor, 99.8 Ω, .25%, .25 W	6-112239
R107	Resistor, 90 Ω, .25%, .25 W	5-116272
R108	Resistor, 9 Ω, .25%, 1 W	5-118410
R109	Resistor, Special, .9 & .088 Ω, .5%	6-112823
R110,124,125, R126,127,130		
R131	Resistor, 100 k, 5%, .25 W	5-118168
R112,114	Resistor, 10 M, 5%, .25 W	5-116632
R111,113,132, R133,135,136 R137,138,139, R140,141	Resistor, 1 M, 5%, .25 W	5-118305
R115	Resistor, 221 k, 1%, .25 W	5-117526
R116	Resistor, 10 k, 1%, .25 W	6-112821
R117	Resistor, 4.7 k, 0.1%, .25 W	6-112820
R118	Resistor, 1 k, 500 V, HV Current Limit	6-112329
R120	Resistor, 26.7 k, 1%, .25 W	6-113159

Replacement Parts

Symbol	Description	Part No.
R121	Resistor, 187 k, 1%, .25 W	6-113158
R122	Potentiometer, 25 k, 20%, .5 W	6-113151
R123	Resistor, 470 k, 5%, .25 W	5-118169
R128	Resistor, 330 k, 5%, .33 W	6-113251
R129	Resistor, .01 Ω, .5%	6-112829
R134	Resistor, 240 k, 10%, .25 W	6-111124
R142	Resistor, 39 k, 5%, .25 W	5-118166
R143	Potentiometer, 20 k, 20%, .5 W	6-112244
R144,R119	Resistor, 18 k, 5%, .25 W	5-119644
R145	Resistor, 10 M, ±5%, .125 W	6-113070
R146	Potentiometer, 5 k, 20%, .5 W	6-112275
SW101	Range Switch	6-112825
SW102	Function Switch	6-112824

Figure 7-1. Schematic Diagram

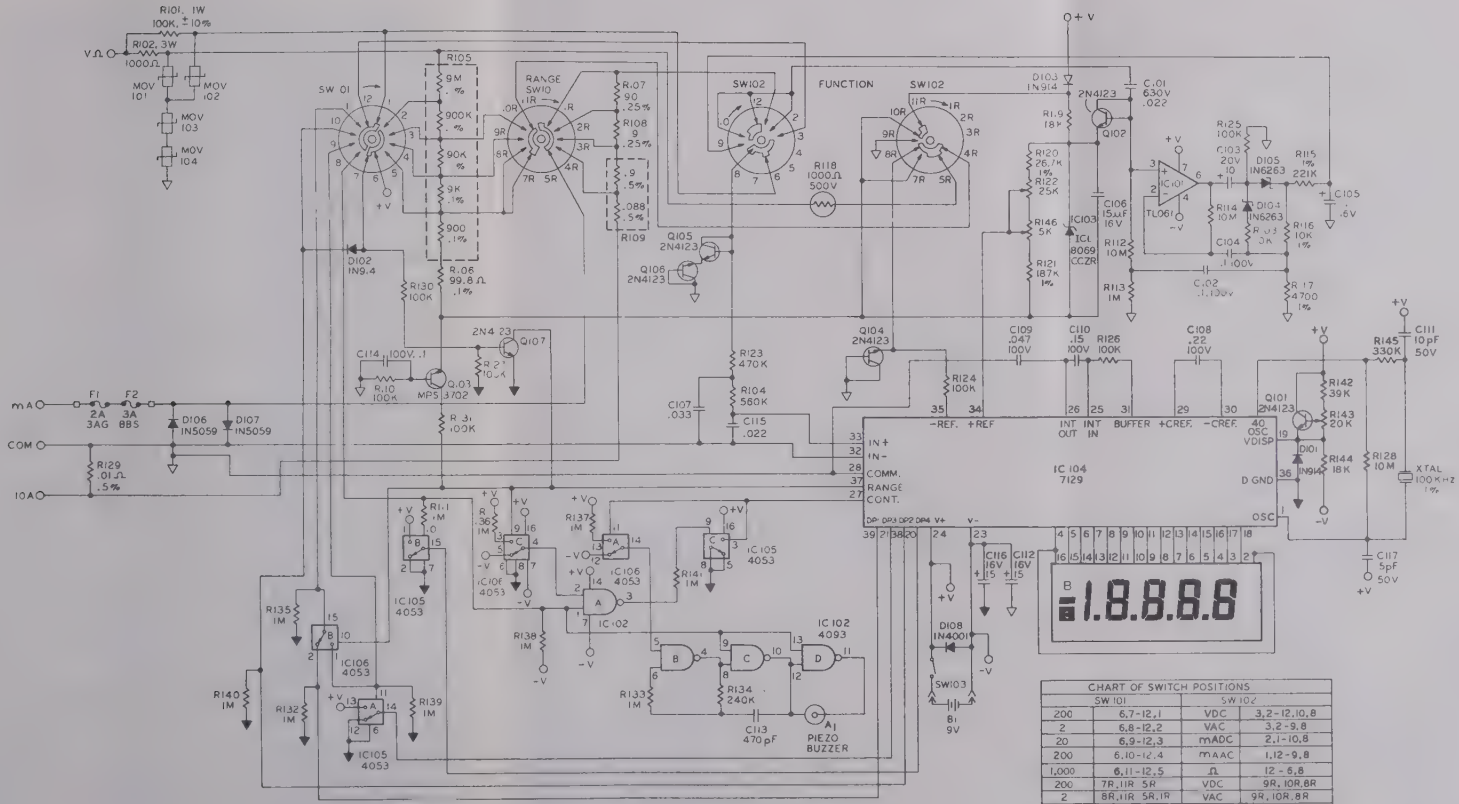

CHART OF SWITCH POSITIONS			
SW101			SW102
200	6,7-12,1	VDC	3,2-12,10,8
2	6,8-12,2	VAC	3,2-9,8
20	6,9-12,3	mADC	2,1-10,8
200	6,10-12,4	mAAC	1,12-9,8
1,000	6,11-12,5	Ω	12-6,8
200	7R,11R 5R	VDC	9R,10R,8R
2	8R,11R 5R,1R	VAC	9R,10R,8R
20	9R,11R-5R 2R	mADC	10R,9R,8R,7R
200	10R,11R-5R,3R	mAAC	9R,8R,7R
1,000	11R-5R,4R	Ω	10R,11R-4R,5R,8R

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTORS IN OHMS, 1/4W, 5%; CAPACITORS IN µF.
2. ⏚ DENOTES ANALOG GROUND
   ⏚ DENOTES DIGITAL GROUND
3. SWITCHES SHOWN IN FULLY CCW POSITION (200Ω)
4. D104 & D105 ARE A MATCHED PAIR.

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630 Haines Avenue NW
Tel. 505/842-1107

★ **NEW YORK, CHADWICKS 13319**
MOHAWK COMMUNICATIONS INC.
3500 Bleachery Place
Tel. 315/737-7328

★★★ **NEW YORK, CLARENCE 14031**
☐ TROTT ELECTRONICS INC.
9020 Wehrle Drive
Tel. 716/634-8500

★★★ **NEW YORK, HAUPPAUGE 11787**
☐ E. I. L. INSTRUMENT
180 Oser Avenue
Tel. 516/231-6333

★★★ **NEW YORK, NEW YORK 10011**
☐ NILSSON ELECTRICAL LABORATORY, INC.
111 8th Avenue - Rm. 1525
Tel. 212/675-7944

★★★ **NEW YORK, ROCHESTER 14621**
☐ EIC ELECTRONICS INC.
85 Avenue E
Tel. 716/544-4392

★★★ **NEW YORK, ROCHESTER 14623**
☐ E. I. L. INSTRUMENTS INC.
1210 Jefferson Road
Tel. 716/424-5750

★★★ **NORTH CAROLINA, CHARLOTTE 28206**
☐ BROWNELL-ELECTRO INC.
3201 Woodpark Blvd
Tel. 704/597-1270

★★★ **NORTH CAROLINA, RALEIGH 27604**
☐ BROWNELL-ELECTRO, INC.
5245 N. Boulevard
Tel. 919/876-6524

★★★ **NORTH CAROLINA, RALEIGH 27604**
☐ METER METRICS
5821 North Boulevard
Tel. 919/872-5456

★★★ **OHIO, CLEVELAND 44105**
☐ PIONEER/INSTRUMENTATION
INSTRUMENT LABORATORY
Div. of Pioneer-Standard Electronics, Inc.
4800 East 131st Street
Tel. 216/587-3600

★★★ **OHIO, CLEVELAND 44136**
WESCHLER ELECTRIC CORP.
16900 Foltz Parkway
Tel. 216/238-2550

★★★ **OHIO, COLUMBUS 43229**
CONTRONICS, INC.
2021 E. Dublin
Granville Road., Suite 192
Tel. 614/846-4034

★★★ **OHIO, DAYTON 45459**
☐ E. I. L. INSTRUMENTS INC.
96A Westpark Road
Tel. 513/435-2134

★★★ **OHIO, DAYTON 45424**
☐ PIONEER/DAYTON
Div. of Pioneer-Standard
Electronics, Inc.
4433 Interpoint Blvd.
Tel. 513/236-9900

★★★ **OKLAHOMA, OKLAHOMA CITY 73107**
☐ HUSTON-DEPUE LABORATORIES INC.
536 N. Pennsylvania St.
Tel. 405/235-5469

★ **OKLAHOMA, TULSA 74120**
AGRA ENGINEERING COMPANY
551 S. Quaker Avenue
Tel. 918/584-4235

★★★ **OREGON, PORTLAND 97217**
☐ WESTCON, INC.
5101 N. Interstate Ave.
Tel. 503/283-0132

★★★ **PENNSYLVANIA, PHILADELPHIA 19115**
☐ SUNSHINE SCIENTIFIC
INSTRUMENTS INC.
1810 Grant Avenue
Tel. 215/673-5600

★★★ **PENNSYLVANIA, PITTSBURGH 15238**
☐ CAM/RPC
620 Alpha Drive RIDC Pk.
Tel. 412/782-3770

★★★ **PENNSYLVANIA, PITTSBURGH 15221**
☐ E. I. L. INSTRUMENTS, INC.
1844 Ardmore Blvd.
Tel. 412/731-5230

★★★ **PUERTO RICO, RIO PIEDRAS 00927**
☐ B&C CALIBRATION
1113-17th St.
Villa Nevarez
Tel. 809/765-2788, 751-8375

★★★ **TENNESSEE, KNOXVILLE 37922**
☐ BROWNELL ELECTRO
207 Center Park Dr.
Tel. 615/966-3441

★★ **TENNESSEE, MEMPHIS 38118**
☐ BROWNELL-ELECTRO INC.
3821 Getwell Road
Tel. 901/795-8487

★★★ **TENNESSEE, MEMPHIS 38104**
INSTRUMENT REPAIR SERVICE
419 N. Watkins
Tel. 901/278-0762

★★★ **TENNESSEE, NASHVILLE 37210**
☐ BROWNELL-ELECTRO INC.
1050 Acorn Drive
Tel. 615/889-8230

★★★ **TEXAS, DALLAS 75248**
☐ E. I. L. INSTRUMENTS, INC.
4392 Sunbelt Drive
Tel. 214/931-1236

★★★ **TEXAS, DALLAS 75229**
☐ ULTRA INSTRUMENT LAB., INC.
10031 Monroe, Suite 101
Tel. 214/357-0297

★★ **TEXAS, GARLAND 75040**
METERMASTER, INC.
2609 National Drive
Tel. 214/271-5671

★★★ **TEXAS, HOUSTON 77081**
☐ E. I. L. INSTRUMENTS, INC.
7385 Ashcroft
Tel. 713/271-3100

★★★ **TEXAS, HOUSTON 77023**
☐ METERS & INSTRUMENTS CORP.
6428 Gulf Freeway
Tel. 713/644-1631

★★★ **TEXAS, HOUSTON 77004**
☐ QUALITY INSTRUMENT LAB INC.
4832 Caroline
Tel. 713/524-0528

★★ **TEXAS, ODESSA 79760**
METER SERVICE & SUPPLY
2127 Kermit Hwy.
P. O. Box 2373
Tel. 915/332-0565

★★★ **TEXAS, ODESSA 79760**
☐ WHITLOCK INSTRUMENT
1306 North Texas
Tel. 915/337-3412

★★★ **VIRGINIA, ALEXANDRIA 22312**
☐ E. I. L. INSTRUMENTS, INC.
5400 Cherokee Avenue
Tel. 703/354-4330

★★★ **VIRGINIA, RICHMOND 23234**
☐ INSTRUMENT TECHNICAL
REPRESENTATIVES
7400 White Pine Road
Tel. 804/275-1431

★★★ **VIRGINIA, VIRGINIA BEACH 23462**
☐ E. I. L. INSTRUMENTS, INC.
5801-A Arrowhead Dr.
Tel. 804/499-3746

★★★ **WASHINGTON, SEATTLE 98108**
☐ E. I. L. INSTRUMENTS, INC.
1312 S. 96th Street
Tel. 206/762-0880

★★★ **WASHINGTON, SEATTLE 98105**
☐ EICHER-RICHARDS COMPANY
2727 N. E. Blakeley Street
Tel. 206/523-7888

★★ **WASHINGTON, SPOKANE 99220**
BLACKS-INDUSTRIAL INC.
N. 401 Helena - Box 3286
Tel. 509/534-9353

★★★ **WISCONSIN, MILWAUKEE 53202**
E-M INSTRUMENTS INC.
153 No. Milwaukee Street
Tel. 414/272-7799

★★ **WYOMING, LANDER 82520**
METER SPECIALISTS, INC.
P. O. Box 595 (Mail)
Hiway 287 West (UPS)
Tel. 307/332-9711

NOTES

FOR THE RECORD

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*Date Purchased*_____

*Purchased From:*_____

*Identification Number:*_____

_____

Date	*Type of Service*	*Serviced By*
____	_____	_____
____	_____	_____
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Quality is the indispensable component of every Simpson instrument. . .